Embedded Solutions

DC1 – Rugged Display Computer

Configuration example

User Manual

mikro elektronik
gmbh · nürnberg

Introduction to the DC1 – Rugged Display Computer

The display computer DC1 is a rugged, fanless and maintenance-free panel PC for harsh, mobile and mission-critical applications in transportation, avionics, medical engineering and industrial automation. Its robust stainless enclosure is protected against violent impacts and designed for a safeguarded use in direct contact with humans, e.g. for infotainment purposes in trains, public buses or airplanes.

The DC1 is controlled by the Intel® Atom™ Z530 running at 1.6 GHz. It comes with 1 GB of DDR2 SDRAM and 4 GB of USB-driven Flash disk. The standard interfaces comprise 2 Fast Ethernet and 2 USB ports as well as four binary inputs (with a fifth used for key input functionality). Its two Ethernet interfaces have switch functionality to provide Ethernet connection to subsequent intelligent displays. A temperature sensor monitors and controls the display.

All I/O signals are concentrated at the bottom side of the DC1. The whole unit can be directly mounted to a VESA mount or side-by-side or back-to-back with a second display.

The standard version of the DC1 complies with the EN 50155, class Tx railway standard (prepared for coating). It is thus for example equipped with an internal 24 VDC nom. (14.4 to 33.6 V) wide-range power supply and able to operate in a -40 to +70°C environment (+85°C for 10 minutes; -30 to +70°C for the display panel with automatic switch-off at excess temperatures).

Technical Data

CPU

- Intel® Atom™ Z530
  - 1.6 GHz processor core frequency
  - 533 MHz system bus frequency
- Chipset
  - Intel® system controller hub US15W

Display

- Screen size: 15"
- Resolution: 1024 x 768 (XGA) with aspect ratio 4:3
- Luminance (cd/m²): 450 cd/m²
- Contrast: 700 typ.
- Viewing angle: 160°/160° (preferred viewing angle 6 o'clock)
- Backlight with brightness control: 2 CCFL min. 50,000 h
- Interface: LVDS
- Visible display area: 305.4 x 229.3 mm
- Monitored and controlled by a temperature sensor
  - Display is turned off at extreme temperatures

Memory

- 1 GB DDR2 SDRAM system memory
  - Soldered
  - 533 MHz memory bus frequency
- 4 GB Flash

I/O

- All I/O available at bottom of housing
  - Invisible from the front
  - Recessed within the housing
- USB
  - Two USB 2.0 host ports
  - Accessible via Series A connectors
  - UHCI implementation
  - Data rates up to 480 Mbits/s
- Ethernet
  - Two 10/100Base-T Ethernet channels
  - Accessible via M12 connectors
  - Switch functionality
- 5 binary inputs
  - 1 for key input functionality
  - 4 universal inputs, e.g. for geographical addressing

Board Management Control

- Supervision of input and internal voltages
- Supervision of CPU and display temperature
- Control of power sequencing and reset behavior of the Intel® Atom™ CPU
- Emergency shutdown in case of failure
- Wake on Time
- Watchdog functionality for CPU with clock generator
- Buffer functionality for RTC and BIOS CMOS
- Accessible via SMBus

Electrical Specifications

- Isolation voltage:
  - 1,500V DC between isolation groups
- Power consumption:
  - 20 W typ.
- Supply voltage:
  - 24 VDC nom. (14.4..33.6 V) according to EN 50155
- Key input functionality
- External power supply unit:
  - 100..240 VAC in, 24 VDC out

Mechanical Specifications

- Dimensions: 360 mm x 284 mm x 55.1 mm
- Weight: 5.2 kg
- Display covered with laminated glass
- Aluminum enclosure
- Prepared for wall mounting
- Front, sides and top protected according to IP54
- Back and bottom protected according to IP21

Environmental Specifications

- Temperature range (operation):
  - -30 to +70°C for the display panel (with automatic switch-off at excess temperatures)
  - -40 to +70°C, with up to 85°C for 10 minutes according to class Tx (EN 50155), for the computer
  - Conductive cooling
  - Fanless operation
- Temperature range (storage): -40..+85°C
- Relative humidity (operation): max. 95% non-condensing
- Relative humidity (storage): max. 95% non-condensing
- Altitude: -300 m to + 3,000 m
- Shock: according to EN 50155 (10.2.11)
- Vibration: according to EN 50155 (10.2.11)

MTBF

- 36,130 h @ +40°C according to IEC/TR 62380 (RDF 2000)

Safety

- PCB manufactured with a flammability rating of 94V-0 by UL recognized manufacturers
- Insulation according to EN 50155 (10.2.9.1)
- Withstand voltage according to EN 50155 (10.2.9.1)
- No edges and burrs
- Temperature gradient between housing and environment smaller than 15°C

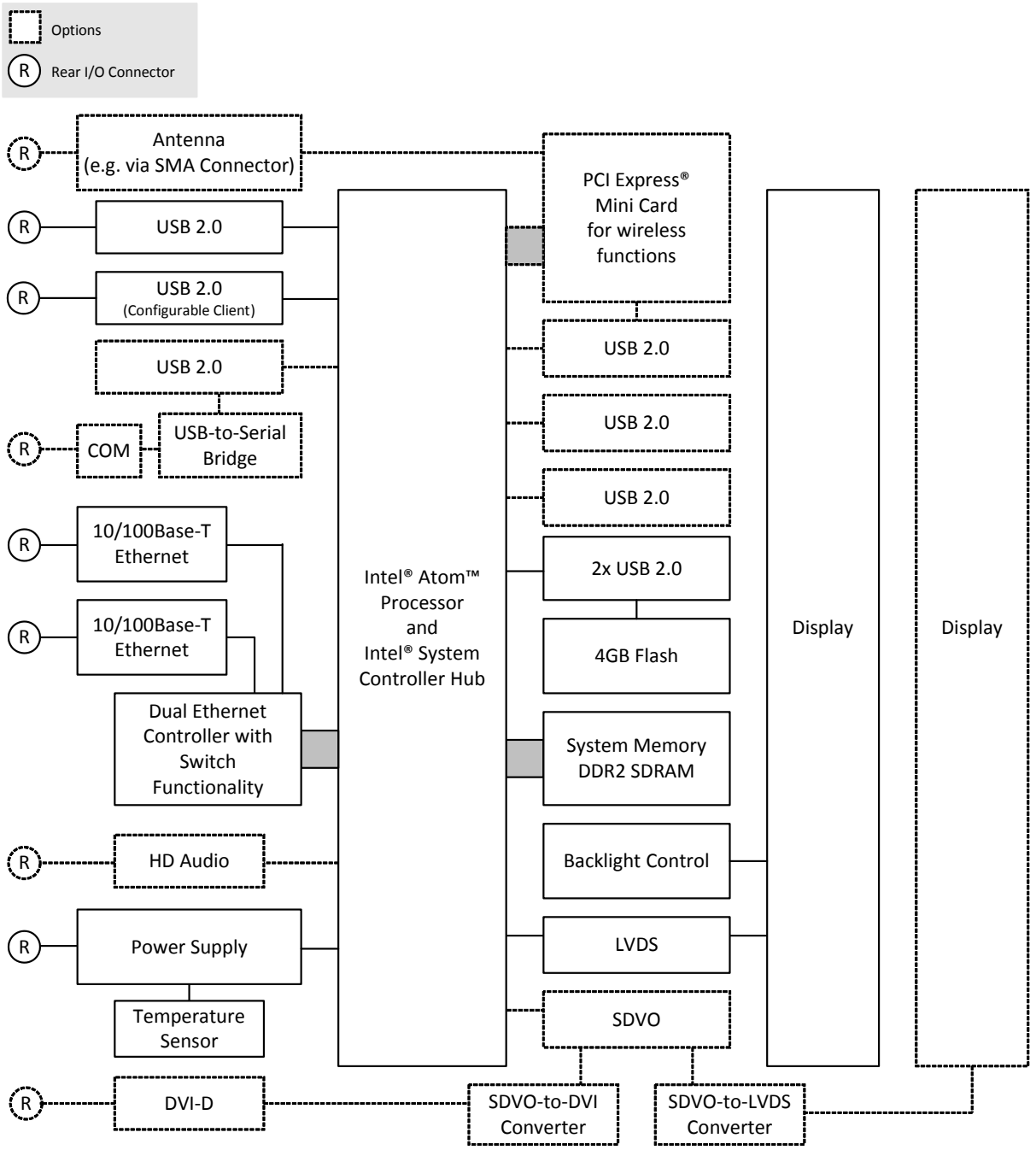
EMC

- Conforming to EN 50155, EN 50121-3-2/EN 61000-4-5

Software Support

- Windows® XP Embedded image included (120-day trial version)
- For more information on supported operating system versions and drivers see online data sheet.

Block Diagram



The DC Family: Flexible Concept – Easy Modification

The DC1 is the first member of a whole family of display computers based on a flexible modular configuration concept. The control electronics is directly attached to the back of the screen, the standard display size being 15". Optional display and housing sizes are 19", 17", and 12" (even smaller sizes possible on request). The computer unit itself builds on the brand new Intel® ultra-mobile low-power processor family starting with the Intel® Atom™ Z530 at 1.6 GHz or Z510 at 1.1 GHz. On request a serial interface can be added and the USB interfaces can be individually configured up to a maximum of 5 ports (alternatively serial interfaces), one of which a client port. A connection for a secondary display (on-board via LVDS or external via DVI-D) can be made accessible, with then two displays able to provide different and equal content at the same time. Additional I/O may optionally comprise HD audio or field bus functions like IBIS. A PCI Express® Mini card slot in combination with an external antenna can be used to incorporate wireless functions like WIFI, WIMAX, GSM/GPRS, UMTS etc. The concept also allows to use different input voltage ranges of the PSUs, for example 48 VDC nom. (28.8 to 67.2V), 72 VDC nom. (43.2 to 100.8 V) or 110 VDC nom. (66 to 154 V) for railway applications. With a typical power consumption of only 20 Watts for the total system the design is always realized without fans, using conductive cooling between the electronics and the display to spread the dissipated heat to the outside of the housing. All electronic components are soldered to withstand shock and vibration and prepared for conformal coating. The housing can be delivered vandal-proof. This display computer series can be qualified according to the applicable quality and security standards of the different markets it has been designed for.

Configuration Options

CPU

- Intel® Atom™ Z530, 1.6 GHz
- Intel® Atom™ Z510, 1.1 GHz

Display

- Secondary display side-by-side or back-to-back with the first via SDVO-to-LVDS converter (same computer)
- Secondary display via SVDO-to-DVI converter for remote operation
- Screen size 12", 15", 17" or 19" (smaller sizes on request)
- Other aspect ratios (e.g. 16:10, 15:9)
- Higher resolutions

I/O

- Up to 6 USB 2.0 host ports (or 5 host ports and 1 client port)
  - If all USBs are used, the serial interface and Flash disk are not available
- HD audio
  - Accessible via 9-pin D-sub connector
  - Amplifier with 1.5 Vrms at 8 ohm
  - Stereo line or amplified out (differential signal)
  - SPDIF out
- DVI-D for remote display
- Serial interface
  - 1 serial interface realized via SA-Adapter™, e.g. RS232 or RS422, isolated or not, IBIS, GPS

PCI Express® Mini card slot

- For functions like WIFI, WIMAX, GSM/GPRS, UMTS
- PCI Express® or USB interface

Electrical Specifications

- Different input voltage ranges for the internal power supply
  - 48 VDC nom. (28.8..67.2 V), 35W according to EN 50155
  - 72 VDC nom. (43.2..100.8 V), 35W according to EN 50155
  - 110 VDC nom. (66..154 V), 35W according to EN 50155

Safety

- Completely vandal-proof

Software

- Linux

As the product concept is very flexible there are many other configuration possibilities. Please contact our sales team if you do not find your required function in the options.

For available standard configurations see online data sheet.

Product Safety

Handling Instructions

- Do not open the DC1. All repairs and changes to the system's internals must be executed by authorized MEN personnel only.
- Do not drop the DC1. Although it is rugged, falls from a considerable height will likely cause damage to the system.
- When mounting the DC1, read the instructions in this manual before consulting the individual installation instructions for the mount used (see Chapter 2.1 Mounting the DC1 using a Flat Display Panel Mounting Interface (VESA mount) on page 26).
- Do not install the DC1 near any heat sources (e.g. radiators, heat registers).
- Keep the DC1 away from liquids. Avoid exposure to dripping or splashing.
- Never handle the system or any connected cables with wet hands.
- Make sure that all peripheral devices are connected to the DC1 before connecting an external power supply and switching on the system.
- The heat sink on the rear of the DC1 may get warm after prolonged use. This is normal.

Electrostatic Discharge (ESD)

Computer boards and components contain electrostatic sensitive devices. Electrostatic discharge (ESD) can damage components. To protect the board and other components against damage from static electricity, you should follow some precautions whenever you work on your computer.

- Power down and unplug your computer system when working on the inside.
- Hold components by the edges and try not to touch the IC chips, leads, or circuitry.
- Use a grounded wrist strap before handling computer components.
- Place components on a grounded antistatic pad or on the bag that came with the component whenever the components are separated from the system.
- Store the board only in its original ESD-protected packaging. Retain the original packaging in case you need to return the board to MEN for repair.

About this Document

This user manual describes the hardware functions of the board. It also provides additional information for special applications and configurations of the board.

The manual does not include detailed information on individual components (data sheets etc.). A list of literature is given in the appendix.

History

Edition	Comments	Date of Issue
E1	First edition	2008-08-06
E2	Major update of firmware section with final commands, removed SMBus On Acknowledge section Added information on display operating tempe-rature/automatic switch-off Corrected pinning of power supply connector Removed mention of second MAC address Added chapter on the included Windows XP Embedded image Standardized information regarding input voltage ranges and serial interfaces Corrected fuse type Several minor corrections (incl. block diagram)	2008-12-19
E3	Added information on Ethernet switch functionality and audio interface Improved depiction of M12 connector	2008-10-27
E4	Added GPS option Added warning regarding connection of both Ethernet ports to the same switch in powerless state Consolidated Firmware Functions chapter, corrected 7-bit SMBus address of the PSU	2011-01-26

Conventions

This sign marks important notes or warnings concerning proper functionality of the product described in this document. You should read them in any case.

italics Folder, file and function names are printed in *italics*.

bold **Bold** type is used for emphasis.

`monospace`	A `monospaced` font type is used for hexadecimal numbers, listings, C function descriptions or wherever appropriate. Hexadecimal numbers are preceded by "0x".
hyperlink	Hyperlinks are printed in blue color.
	The globe will show you where hyperlinks lead directly to the Internet, so you can look for the latest information online.
IRQ# /IRQ	Signal names followed by "#" or preceded by a slash ("/") indicate that this signal is either active low or that it becomes active at a falling edge.
in/out	Signal directions in signal mnemonics tables generally refer to the corresponding board or component, "in" meaning "to the board or component", "out" meaning "coming from it".
	Vertical lines on the outer margin signal technical changes to the previous edition of the document.

Legal Information

MEN Mikro Elektronik reserves the right to make changes without further notice to any products herein. MEN makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does MEN assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages.
"Typical" parameters can and do vary in different applications. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts.
MEN does not convey any license under its patent rights nor the rights of others.
Unless agreed otherwise, MEN products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the MEN product could create a situation where personal injury or death may occur. Should Buyer purchase or use MEN products for any such unintended or unauthorized application, Buyer shall indemnify and hold MEN and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that MEN was negligent regarding the design or manufacture of the part.

Unless agreed otherwise, the products of MEN Mikro Elektronik are not suited for use in nuclear reactors and for application in medical appliances used for therapeutical purposes. Application of MEN products in such plants is only possible after the user has precisely specified the operation environment and after MEN Mikro Elektronik has consequently adapted and released the product.

ESM™, MDIS™, MDIS4™, MENMON™, M-Module™, M-Modules™, SA-Adapter™, SA-Adapters™, UBox™ and USM™ are trademarks of MEN Mikro Elektronik GmbH. PC-MIP® is a registered trademark of MEN Micro, Inc. and SBS Technologies, Inc. MEN Mikro Elektronik®, ESMexpress® and the MEN logo are registered trademarks of MEN Mikro Elektronik GmbH.

PowerPC® is a registered trademark of IBM Corp. Intel® Atom™ and Intel® Core™ are trademarks of Intel, Inc. Celeron®, Intel®, Pentium® and Xeon® are registered trademarks of Intel, Inc. COM Express™ is a trademark of PCI Industrial Computer Manufacturers Group. CompactPCI® is a registered trademark of PCI Industrial Computer Manufacturers Group. Microsoft® and Windows® are registered trademarks of Microsoft Corp. Windows® Vista™ is a trademark of Microsoft Corp. PCI Express® and PCIe® are registered trademarks of PCI-SIG. Phoenix® is a registered trademark of Phoenix Technologies Ltd.

All other products or services mentioned in this publication are identified by the trademarks, service marks, or product names as designated by the companies who market those products. The trademarks and registered trademarks are held by the companies producing them. Inquiries concerning such trademarks should be made directly to those companies. All other brand or product names are trademarks or registered trademarks of their respective holders.

Information in this document has been carefully checked and is believed to be accurate as of the date of publication; however, no responsibility is assumed for inaccuracies. MEN Mikro Elektronik accepts no liability for consequential or incidental damages arising from the use of its products and reserves the right to make changes on the products herein without notice to improve reliability, function or design. MEN Mikro Elektronik does not assume any liability arising out of the application or use of the products described in this document.

Copyright © 2011 MEN Mikro Elektronik GmbH. All rights reserved.

Please recycle

MEN Mikro Elektronik GmbH
Neuwieder Straße 5-7
90411 Nuremberg
Phone +49-911-99 33 5-0
Fax +49-911-99 33 5-901
E-mail info@men.de
www.men.de

France
MEN Mikro Elektronik SA
18, rue René Cassin
ZA de la Châtelaine
74240 Gaillard
Phone +33 (0) 450-955-312
Fax +33 (0) 450-955-211
E-mail info@men-france.fr
www.men-france.fr

USA
MEN Micro, Inc.
24 North Main Street
Ambler, PA 19002
Phone (215) 542-9575
Fax (215) 542-9577
E-mail sales@menmicro.com
www.menmicro.com

Contents

1 System Overview 18
1.1 Layout of the DC1 18
1.2 External 100..240V AC Power Supply 20
1.3 Internal 24V DC Power Supply 20
1.4 Interfaces 21
1.4.1 USB Interface 21
1.4.2 Ethernet Interface 22
1.4.3 Binary Inputs 23
1.4.4 DVI-D Interface (optional) 24
1.4.5 Serial interface (optional) 24
1.4.6 HD Audio Interface (optional) 25
1.4.7 Wireless interface (optional, e.g. SMA connector) 25

2 Getting Started 26
2.1 Mounting the DC1 using a Flat Display Panel Mounting Interface (VESA mount) 26
2.2 Using the included External Power Supply 26
2.3 Using a customized Power Supply 26
2.4 Power Down 27
2.5 Installing Operating System and Driver Software 27

3 Firmware Functions 28
3.1 Onboard Microcontroller 28
3.2 SMBus Functionality 29
3.2.1 SMBus Interface 29
3.2.2 Wake On Time 29
3.2.3 Watchdog 30
3.2.4 Status of Binary Inputs 31
3.2.5 Key Input 31
3.2.6 Shutdown 31
3.2.7 Shutdown Delay 32
3.2.8 Voltage Supervision 34
3.2.9 Temperature Supervision 34
3.2.10 Display Backlight Power and Brightness Control 35
3.2.11 Optional Autonomous Brightness Control with Photo Diode 36
3.2.12 Miscellaneous Commands 36

4 Maintenance 37
4.1 Cleaning the Display 37
4.2 Fuse Protection 37

5 Appendix 38
5.1 Literature and Web Resources 38

5.2 Finding out the Display Computer's Article Number, Revision and Serial Number 38

Figures

Figure 1. The DC1 - front view 18
Figure 2. The DC1 - bottom view (shown with standard connectors only). 18
Figure 3. The DC1 - rear view 19
Figure 4. Connectors at the bottom side of the DC1 21
Figure 5. Microcontroller block diagram. 28
Figure 6. Label giving the board's article number, revision and serial number 38

Tables

Table 1. Pin assignment of the USB connectors. 21
Table 2. Signal mnemonics of the USB connectors 21
Table 3. Pin assignment of the Ethernet M12 connectors 22
Table 4. Pin assignment of the power supply/binary inputs 7W2 D-Sub connector 23
Table 5. Signal mnemonics of the binary inputs 23
Table 6. Pin assignment of the DVI output 24
Table 7. Signal mnemonics of the DVI output 24
Table 8. Pin assignment of the HD audio interface 25
Table 9. Signal mnemonics of the HD audio interface. 25
Table 10. SMBus commands for wake on time function 29
Table 11. SMBus commands XC02C_WOT_L / XC02C_WOT_H 29
Table 12. SMBus commands for the watchdog function 30
Table 13. SMBus command XC02C_WDOG_TOUT 30
Table 14. SMBus commands for binary inputs status 31
Table 15. SMBus command for shutdown by software function 31
Table 16. SMBus commands for shutdown delay 32
Table 17. SMBus command XC02C_STATUS 32
Table 18. SMBus command XC02C_DOWN_DELAY 32
Table 19. SMBus command for Off delay function 33
Table 20. SMBus command XC02C_OFF_DELAY 33
Table 21. SMBus command for Off acknowledge function. 33
Table 22. SMBus command for voltage supervision function 34
Table 23. SMBus commands for temperature supervision. 35
Table 24. Temperature representation 35
Table 25. SMBus commands for display control 36
Table 26. SMBus commands for PSU ID and firmware revision number 36

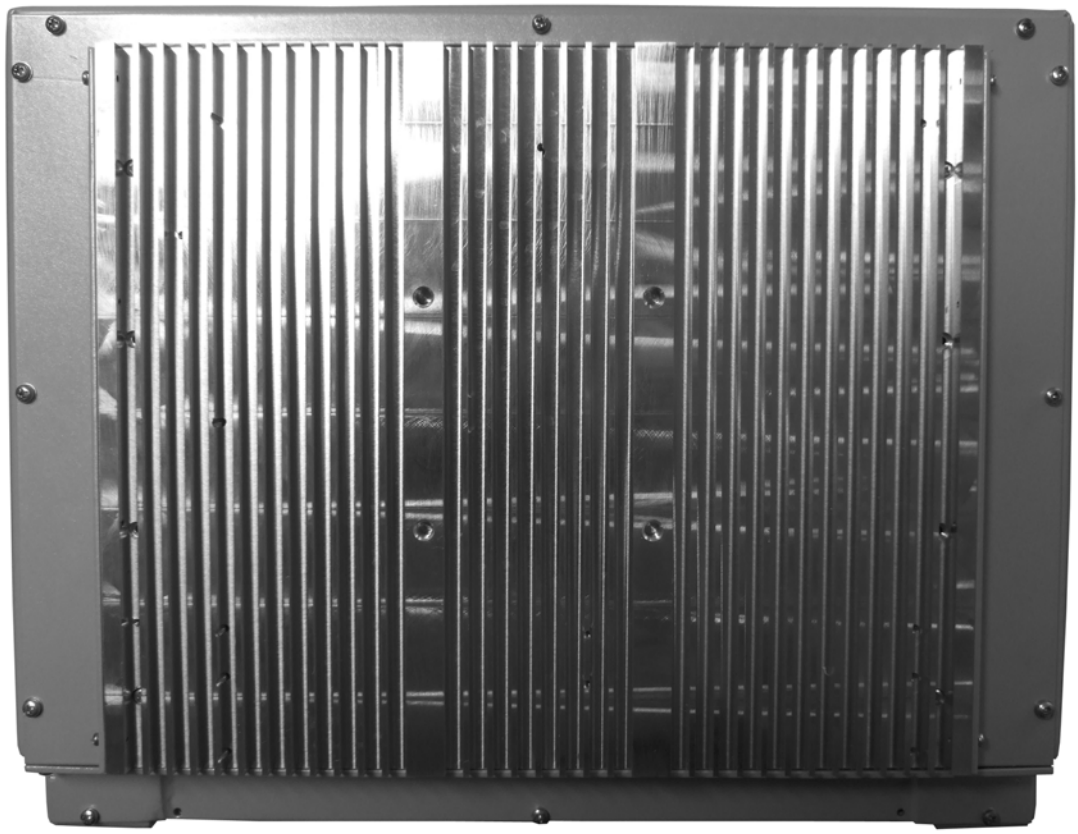
1 System Overview

1.1 Layout of the DC1

Figure 1. *The DC1 - front view*

Figure 2. *The DC1 - bottom view (shown with standard connectors only)*

Figure 3. *The DC1 - rear view*



1.2 External 100..240V AC Power Supply

The DC1 usually comes with an external power supply (with a 100..240V AC to 24V DC converter) to power the system outside of custom installations (e.g. during setup and testing). For more information see Chapter 2.2 Using the included External Power Supply on page 26.

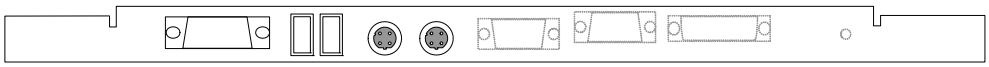
1.3 Internal 24V DC Power Supply

The DC1 usually comes with an internal 24VDC nom. (14.4 to 33.6V) wide-range power supply. It is connected via a mixed 7W2 D-Sub connector that also provides a binary input for key input functionality. Power supply units with other input voltage ranges (up to 110V nom. for railway applications) are also available from MEN to suit individual projects' needs. Please refer to the Table 4, Pin assignment of the power supply/binary inputs 7W2 D-Sub connector, on page 23 for further details.

1.4 Interfaces

The DC1 offers a plethora of connections at the bottom side of the unit (from left to right as depicted):

Figure 4. *Connectors at the bottom side of the DC1*

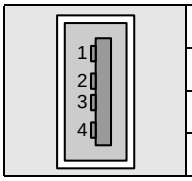


- Power supply with 5 binary inputs (through mixed 7W2 D-Sub connector)
- 2x USB 2.0
- 2x Fast Ethernet
- Serial interface (optional)
- HD audio (optional)
- DVI-D (optional)
- Antenna connector (optional, e.g. SMA connector)

1.4.1 USB Interface

The DC1 comes with two USB 2.0 ports supporting data rates up to 480Mbits/s, UHCI implementation and external PHY functions.

Table 1. *Pin assignment of the USB connectors*



1	+5V
2	USB_D-
3	USB_D+
4	GND

Table 2. *Signal mnemonics of the USB connectors*

Signal	Direction	Function
+5V	out	+5 V power supply
GND	-	Digital ground
USB_D+, USB_D-	in/out	USB lines, differential pair

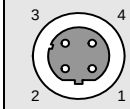
1.4.2 Ethernet Interface

The DC1 comes with two Fast Ethernet ports with switch functionality. They are available through rugged M12 "D coding" female connectors of type Erni P/N 234041.

Both half and full duplex mode are supported. Switching functionality is provided for forwarding of Ethernet frames to subsequent intelligent displays. The DC1 also supports powerless forwarding of Ethernet frames: The unit's onboard switch is bypassed when the Ethernet circuit is not supplied with its intended voltage. Thus, a switched off or defective DC1 unit does not interrupt the Ethernet traffic in a daisy chain configuration.

Note that the two Ethernet ports are connected via a relay while the DC1 is in powerless state, so connecting both to the same switch will likely jam the network.

Table 3. *Pin assignment of the Ethernet M12 connectors*

	Pin	Name	Description
	1	TX+	Transmitter positive output
	2	RX+	Receiver positive input
	3	TX-	Transmitter negative output
	4	RX-	Receiver negative input

The Ethernet controller has its own EEPROM to store the MAC address etc.

The unique MAC address is set at the factory and should not be changed. Any attempt to change this address may create node or bus contention and thereby render the unit inoperable. The MAC address on the DC1 is:

- LAN0: `0x 00 C0 3A 85 xx xx`

where "`00 C0 3A`" is the MEN vendor code, "`85`" is the MEN product code and "`xx xx`" is the hexadecimal serial number of the DC1's carrier board, e. g. "... `00 2A`" for the serial number "000042".

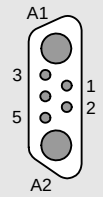
Please note that due to the structure of the DC1, the serial number of the unit's carrier board is different from the serial number of the entire DC1 unit. For the unit's overall serial number please refer to Chapter 5.2 Finding out the Display Computer's Article Number, Revision and Serial Number on page 38.

1.4.3 Binary Inputs

The mixed 7W2 D-Sub power supply connector of the DC1 provides five binary inputs. The binary inputs are isolated from each other and the isolated system ground. The input voltage range is from 0 V up to the input voltage. The nominal switching level is 9 V. The current is 5 mA. This value is independent of the input voltage.

There are four inputs dedicated to the geographical addressing of the DC1 and one key input. The state of the binary inputs can be read via the SMBus interface. See Chapter 3.2.4 Status of Binary Inputs on page 31.

Table 4. *Pin assignment of the power supply/binary inputs 7W2 D-Sub connector*



1	POSITION_EXT[1]
2	POSITION_EXT[3]
3	PWR_ON_EXT
4	POSITION_EXT[2]
5	POSITION_EXT[4]
A1	I+24V
A2	IGND_3

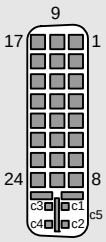
Table 5. *Signal mnemonics of the binary inputs*

Signal	Direction	Function
PWR_ON_EXT	in	Key input
POSITION_EXT_[x]	in	Binary inputs for geographical adderssing
I+24V	in	+24V power supply
IGND_3	-	Analog ground

1.4.4 DVI-D Interface (optional)

The DC1 optionally offers a DVI-D connector that makes it possible to connect a second display. The two displays can be used to show the same or different content depending on the Windows XP Embedded display settings.

Table 6. *Pin assignment of the DVI output*



	17	TX0-	9	TX1-	1	TX2-
	18	TX0+	10	TX1+	2	TX2+
	19	GND	11	GND	3	GND
	20	-	12	-	4	-
	21	-	13	-	5	-
	22	GND	14	DDCPOW	6	DDCL
	23	TXC+	15	GND	7	DDCA
	24	TXC-	16	DVIHP	8	-
	C3	-			C1	-
			C5	-		
	C3	-			C2	-

Table 7. *Signal mnemonics of the DVI output*

Signal	Direction	Function
DDCA	out	Display Data Channel data
DDCL	out	Display Data Channel clock
DDCPOW	out	Display Data Channel Power, +5V; current-limited to 1.5A by a fuse[1]
DVIHP	in	DVI hot plug detect
GND	-	Digital ground
TX[0..2]+, TX[0..2]-	out	Transmit data lines (TMDS), differential pairs
TXC+, TXC-	out	TX clocks (TMDS clock), differential pair

[1] The DVI fuses used on the DC1 are PolyFuses and therefore need no maintenance

1.4.5 Serial interface (optional)

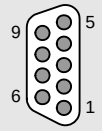
The Serial interface is an optional feature of the DC1 and is realized via an SA-Adapter. You can use different types of SA-Adapters with the DC1, e.g. isolated and non-isolated adapters for RS232 and IBIS master and slave interfaces. These interfaces are accessible by means of a 9-pin D-Sub connector on the SA-Adapter on the bottom side of the DC1. Another option is a GPS interface with a rugged SMA connector.

Please note that SA-Adapters must be installed by authorized MEN personnel only. Do not open the DC1!

1.4.6 HD Audio Interface (optional)

The DC1 offers an optional HD audio output with an amplifier with 1.5 Vrms at 8 ohm via a 9-pin D-Sub connector. It provides both analog and digital audio.

Table 8. *Pin assignment of the HD audio interface*



9	AUDIO_IN_R	5	AUDIO_SPDIF
8	AUDIO_GND	4	AUDIO_IN_L
7	AUDIO_OUT_R+	3	AUDIO_OUT_R-
6	AUDIO_OUT_L-	2	AUDIO_GND
		1	AUDIO_OUT_L+

Table 9. *Signal mnemonics of the HD audio interface*

Signal	Direction	Description
AUDIO_EXT_OUT_L±/R±	out	Line out, left and right, differential signal pairs
AUDIO_EXT_IN_L/R	in	Line in, left and right
AUDIO_EXT_GND	-	Analog ground
AUDIO_EXT_SPDIF	out	S/PDIF output

1.4.7 Wireless interface (optional, e.g. SMA connector)

A PCI Express Mini card can be used to incorporate wireless functions like WIFI, WIMAX, GSM/GPRS or UMTS. In that case the DC1 is usually equipped with an SMA antenna connector. The standard position for this connector is on the right side at the bottom (other positions can be realized on request). A SIM card can be used as the unit offers a SIM card slot inside.

Please note that PCI Express Mini cards and SIM cards must be installed by authorized MEN personnel only. Do not open the DC1!

2 Getting Started

2.1 Mounting the DC1 using a Flat Display Panel Mounting Interface (VESA mount)

The DC1 is designed for mounting using a Flat Display Mounting Interface (commonly known as VESA mount). For the standard 15" DC1 the width and height of the mounting hole pattern is 75x75 mm. Make sure to use four M6x1 10mm screws to attach the DC1 to the VESA mount. Do not use the M4 screws that are often included with VESA MIS-D 75 compliant mounts! Except for the recommended screw size, follow the individual installation instructions for the mount you are using.

Please note that depending on the size of the display used and the weight of the system, different mounting hole patterns and sizes might apply for other models.

2.2 Using the included External Power Supply

The DC1 comes with an external power supply to allow for quick and easy setup and testing. Simply attach the external power supply's power cord to a standard 230V AC power outlet and the mixed 7W2 D-Sub plug to the power input of the DC1. The DC1 will start up immediately, because the key input signal from the external power supply is constantly active.

Make sure that all peripheral devices are connected to the DC1 before connecting the external power supply!

If the external power supply remains active after a system shutdown, you can also turn the DC1 on by Wake on time via the SMBus interface (see Chapter 3.2.2 Wake On Time on page 29).

2.3 Using a customized Power Supply

When using a custom power supply soluton instead of the included external power supply, you must be aware of the DC1's key input functionality (see Chapter 3.2.5 Key Input on page 31). Simply supplying the internal 24VDC power supply with power will not power up the system when there is no key input voltage present on the binary input 3 of the power connector. To bypass the key input feature, connect V_{in} with Key_{in} for a constantly active key input signal.

When the DC1 is connected to a customized power supply and supplied with 24V DC, the system can be switched on in the following two ways:

- Key input (ignition key) via isolated binary input (see Chapter 3.2.5 Key Input on page 31). The switching threshold is 9VDC.
- Wake on time via the SMBus interface (see Chapter 3.2.2 Wake On Time on page 29).

Make sure that all peripheral devices are connected to the DC1 before switching on the system!

2.4 Power Down

The DC1 can be switched off in the following three ways:

- Key input (ignition key) via isolated binary input. The system will shut down without key input voltage (see Chapter 3.2.6.2 Shutdown by Key Input on page 32).
- Shutdown by application software: the shutdown can be signaled via an SMBus command from application to host (see Chapter 3.2.6.1 Shutdown by Software on page 31).

- Disconnecting the DC1 from any external power supply. Please note that Windows XP Embedded, the pre-installed operating system of the DC1, needs a controlled power down sequence. This means that using this method to power down the DC1 can result in corrupted data. Make sure you shut down the operating system before disconnecting any external power supply!

2.5 Installing Operating System and Driver Software

The DC1 comes with a 120-day trial version of Windows XP Embedded and all necessary drivers pre-installed on its 4 GB USB-driven Flash disk. Please refer to the respective software documentation for a detailed description and configuration options.

During the first power up of the system, the First Boot Agent software will be executed automatically. This will take approximately 45 minutes. No action on behalf of the user is necessary at this time. The 120-day trial period starts the moment the First Boot Agent finishes setting up the system.

Please note that the battery-powered internal clock of the DC1 is used to determine how much of the trial period remains.

The following events can cause the trial period to end prematurely:

- The BIOS time is modified.
- The CPU is separated from the carrier board (the battery is located on the carrier board, so the CPU's internal clock is no longer buffered).
- A BIOS update has unforeseen side-effects.

Should any of this happen and render the trial version of Windows XP Embedded unusable prematurely, please contact MEN.

A board support package (BSP) containing all the necessary, hardware-specific components to create an individualized Windows XP Embedded will be made available on MEN's website. A complete log of the standard Windows XP Embedded image used on the DC1 is available from MEN on request.

3 Firmware Functions

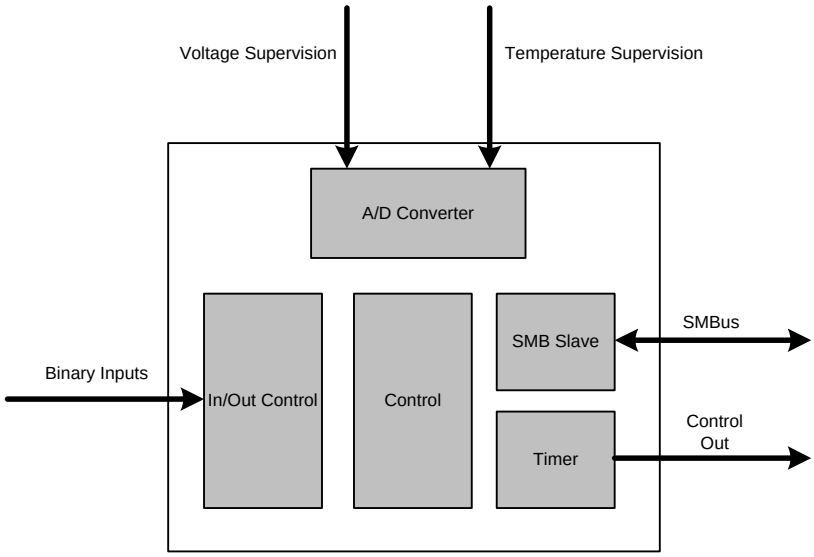
The functions of the XC02BC board controller described in the following chapter depend on the firmware. This user manual describes the functions as realized in the current MEN standard firmware. To access the functions described below from own applications, MEN provides the Windows Installset 13XM01-77 and an OS-independent MDIS driver package, 13XC02-06. Please also refer to the general MDIS documentation for details.

3.1 Onboard Microcontroller

The DC1 is equipped with an intelligent internal power supply. Its onboard microcontroller is used as a control and supervision device of the DC/DC converter, the binary inputs of the DC1, its temperature and its display. Additionally, it is used as a watchdog for the CPU and the microcontroller itself. The microcontroller is connected to the CPU via SMBus. It is able to keep the power supply active even if the external on/off-signal goes inactive. The microcontroller controls the reset signal to be able to reset the CPU.

Windows XP Embedded, the pre-installed operating system of the DC1, needs a controlled power down sequence. The power supply of the CPU can be kept active via the SMBus even when the external on/off signal of the DC1 is inactive so that a controlled power down of the operating system is possible. For further information see Chapter 3.2.7.1 Off Delay on page 33.

Figure 5. *Microcontroller block diagram*



3.2 SMBus Functionality

3.2.1 SMBus Interface

The DC1's internal power supply supports SMBus slave device functionality. The 7-bit SMBus address of the power supply unit is 0x09. Its microcontroller behaves according to the SMBus Specification Version 2.0. The supported SMBus commands and their functions are explained in the following chapters. The commands are listed by their unique name. The "Data Range" column lists the valid range of the data byte for the specific command code. The "Type" column specifies the data direction for the specific command. 'r' specifies that the host can read the data using the SMBus read-byte protocol. 'w' means the host can write data using the SMBus write-byte protocol.

3.2.2 Wake On Time

The DC1 can be switched on/off by a programmable timer. The timer is included in the internal power supply unit's microcontroller and is programmable by the CPU via SMBus commands (see Table 10, SMBus commands for wake on time function, on page 29).

The behavior after power up by wake on time is identical to the behavior after power up by key input. After the first wake on time event, the wake on time feature is disabled.

Note: For the timer functionality it is necessary that the DC/DC converter and the microcontroller are active, i.e. the power supply unit is connected to the DC/DC converter, which is supplied with power. The DC1 will consume approx. 800 mW in this state.

Table 10. *SMBus commands for wake on time function*

Name	Command Code	Data Range	Type	Description
XC02C_WOT_L	0x00	0x00.. 0xFF	r/w	Wake on time low byte
XC02C_WOT_H	0x01	0x00.. 0xFF	r/w	Wake on time high byte

The wake on time delay can be configured via SMBus in a 16 bit counter to provide the range according to the following table:

Table 11. *SMBus commands XC02C_WOT_L / XC02C_WOT_H*

Minimum	Maximum	Description
0 (OFF) (default)	65,535 min (45d 12h 15m)	*XC02C_WOT_L* and *XC02C_WOT_H* build a 16 bit value which represents the time in minutes

A user application that shall switch on the DC1 on a given date and time needs to calculate the amount of minutes between shutdown and desired wake time.

3.2.3 Watchdog

The internal power supply unit's microcontroller is also used as a watchdog for the DC1 system.

It is possible to enable/disable the watchdog by the SMBus command *XC02C_WDOG_STATE*. After the *XC02C_STATUS* byte (see Table 16, SMBus commands for shutdown delay, on page 32) signals a shutdown, the watchdog is disabled by the firmware. The watchdog is triggered by cyclic SMBus commands (*XC02C_WDOG_TRIG*) from the CPU. The time interval between trigger commands is configurable via the SMBus command *XC02C_WDOG_TOUT* (see Table 13, SMBus command XC02C_WDOG_TOUT, on page 30). The time interval is set to its maximum value after DC1 power up and the watchdog is disabled. In case of a missing trigger unit's microcontroller resets the complete system. The number of missing SMBus trigger command exceptions is incremented and can be read via the SMBus command *XC02C_WDOG_ERR*.

After three exceptions, the microcontroller switches off the power output (V_{out}) and switches off the display.

Table 12. *SMBus commands for the watchdog function*

Name	Command Code	Data Range	Type	Description
XC02C_WDOG_STATE	0x05	0x00, 0x01	r/w	Watchdog state
XC02C_WDOG_TRIG	0x06	0	w	Watchdog trigger signal
XC02C_WDOG_TOUT	0x07	0x01.. 0xFF	r/w	Watchdog timeout in 100ms steps
XC02C_WDOG_ERR	0x08	0x00.. 0x04	r	Number of missing on watchdog trigger signals

Table 13. *SMBus command XC02C_WDOG_TOUT*

Value	Watchdog Timeout
1	100 ms
2	200 ms
3	300 ms
...	
255	25.5 s (default)

3.2.4 Status of Binary Inputs

The status of the binary inputs is also signaled via SMBus commands. See Table 14, SMBus commands for binary inputs status, on page 31.

Table 14. *SMBus commands for binary inputs status*

Name	Command Code	Data Range	Type	Description
XC02C_IN	0x0E	0x00.. 0x1F	r	State of binary inputs

The binary inputs represent the status of the key input and the 4 geographical address inputs that allow a user application to find out e.g. where in a train a DC1 is located.

3.2.5 Key Input

One of the binary inputs serves as an on/off input. When this signal is passive (open) during power up of the input voltage, the system is not supplied with power. When this signals goes active, the microcontroller switches the power supply to provide the system with power. Regardless of the key input signal, the DC/DC converter and the microcontroller are always supplied with power when the input voltage is connected.

Note that key input functionality is only available when using a customized power supply, as the key input signal from the included external power supply is always active.

3.2.5.1 Key Input On

The microcontroller switches on the system power whenever the debounced state of the key binary input switches from low to high state (On event). The microcontroller debounces the key input in the following way: if the input is stable for 250ms, the input state is interpreted.

3.2.6 Shutdown

3.2.6.1 Shutdown by Software

At any time it is possible to shut down the power supply by software via SMBus command *XC02C_SWOFF*. A shutdown by software is caused when an SMBus byte write of 0x09 (command) and 0xA8 (magic value to avoid unintended shutdowns) is done to the microcontroller's address.

Table 15. *SMBus command for shutdown by software function*

Name	Command Code	Data Range	Type	Description
XC02C_SWOFF	0x09	0xA8 (magic)	w	Signal a software power off from application

3.2.6.2 Shutdown by Key Input

When using a customized power supply, it is possible at any time to shut down the power supply by switching off the key input. A shutdown by key input follows the shutdown sequence.

3.2.7 Shutdown Delay

During the shutdown sequence the microcontroller provides a programmable shutdown delay. The default state of the shutdown delay after power up of the DC1 is 0 (disabled). The shutdown delay is configurable via the SMBus command *XC02C_DOWN_DELAY*, see Table 16, SMBus commands for shutdown delay, on page 32 and Table 18, SMBus command XC02C_DOWN_DELAY, on page 32. The shutdown delay timer is started after shutdown event. At any time during the shutdown delay the shutdown sequence can be stopped by an On event (key input on). The system is in running state then and the shutdown delay timer is cleared.

Table 16. *SMBus commands for shutdown delay*

Name	Command Code	Data Range	Type	Description
XC02C_DOWN_DELAY	0x0B	0x00.. 0x07	r/w	Shutdown delay
XC02C_STATUS	0x0D	0x00.. 0x01	r	Signal PSU status to application

Table 17. *SMBus command XC02C_STATUS*

Bit	Value	Description
0	0	Shutdown event not signaled
	1	Signal shutdown event
1	0	Normal operation
	1	Display in protect state (over/under-voltage or temperature)
2..7	0	Reserved

Table 18. *SMBus command XC02C_DOWN_DELAY*

Value	Shutdown Delay
0	0 min
1	1 min
2	2 min
3	4 min
4	8 min
5	16 min
6	32 min
7	64 min

3.2.7.1 Off Delay

During the shutdown sequence the microcontroller provides a programmable Off delay. As default this feature is not enabled (mode 0). In this case there will be no Off delay, the supply will be switched off immediately. When enabled (mode 1…5), the microcontroller starts the Off delay timer after signaling the shutdown event to the CPU. After timeout the microcontroller switches off the supply voltage (V_{out}). V_{out} is kept disabled for at least 1 s, even if an immediate On event occurs. This guarantees a proper power on reset of the supplied system. The Off delay can be programmed using the SMBus command *XC02C_OFF_DELAY*, for details see Table 19, SMBus command for Off delay function, on page 33 and Table 20, SMBus command XC02C_OFF_DELAY, on page 33.

Table 19. *SMBus command for Off delay function*

Name	Command Code	Data Range	Type	Description
XC02C_OFF_DELAY	0x0C	0x00.. 0x05	r/w	Off delay

Table 20. *SMBus command XC02C_OFF_DELAY*

Mode value	Off Delay
0	Feature off (no Off delay, default)
1	1 min
2	2 min
3	4 min
4	8 min
5	16 min

3.2.7.2 Off Acknowledge

The microcontroller provides a possibility to acknowledge the shutdown. It is possible at any time during Off delay to shut down the power supply by the SMBus command *XC02C_OFFACK*.

Table 21. *SMBus command for Off acknowledge function*

Name	Command Code	Data Range	Type	Description
XC02C_OFFACK	0x0A	0	w	Signal Off acknowledge

3.2.8 Voltage Supervision

Input and output voltage are supervised by the microcontroller. The microcontroller supervises the 12 V output voltage of the DC/DC converter by applying it through a voltage divider to one ADC channel. The supervision ranges are set by the commands XC02C_VOLT_HIGH and XC02C_VOLT_LOW. These values are written with MDIS descriptors and are not to be changed during normal operation. When the voltage is exceeding this range, the display is switched off for protection.

The output voltage is measured using the microcontroller internal ADC function. The ADC value which represents the output voltage can be read via the SMBus command *XC02C_VOLT* (see Table 22, SMBus command for voltage supervision function, on page 34. With an ADC reference voltage of 3.00 volts the returned value from this command is to be interpreted as

$$U_{\mathrm{mon}} = \frac{ADC}{255} x 3000mV$$

so that for example a returned value of 0xD5 corresponds to (0xD5/255)*3000mV = 2.506V. This value results from the voltage divider tap between a 10k and 2.7k resistor (factor 0.212), so the real output voltage of the DC/DC converter is 2.506V/ 0.212 = 11.8V. This would be a typical output under load.

Table 22. *SMBus command for voltage supervision function*

Name	Command Code	Data Range	Type	Description
XC02C_VOLT	0x14	0x00.. 0xFF	r	DC/DC output (voltage divider factor = 0,212)
XC02C_VOLT_LOW	0x22	0x00.. 0xFF	r/w	Minimum allowed display supply voltage
XC02C_VOLT_HIGH	0x21	0x00.. 0xFF	r/w	Maximum allowed display supply voltage

3.2.9 Temperature Supervision

The microcontroller is able to determine the temperature inside the DC1. The CPU can read the current temperature via the SMBus command *XC02C_TEMP*. This is independent from the temperature sensor and supervision functionality of the DC1's embedded system core itself.

The temperature supervision is carried out by the temperature sensor LM50. The LM50 is a precision integrated-circuit temperature sensor that can sense a -40°C to +125°C temperature range. It converts its temperature to an analog voltage according to the formula below:

OUTPUT

Vout=(10mV/°C x Temp °C) + 500 mV

Vout=+1.750mV at +125°C

Vout=+750mV at +25°C

Vout=+100mV at -40°C

This voltage is also converted as explained in Chapter 3.2.8 Voltage Supervision, but directly attached to the ADC channel since it is within the maximum ADC range of 3,000V. The Table 24. Temperature representation shows some values (which are derived by (Vout/3000mV) x 0xFF).

Table 23. *SMBus commands for temperature supervision*

Name	Command Code	Data Range	Type	Description
XC02C_TEMP	0x12	0x00.. 0xFF	r	Converted temperature
XC02C_TEMP_LOW	0x18	0x00.. 0xFF	r/w	Minimum temperature value
XC02C_TEMP_HIGH	0x13	0x00.. 0xFF	r/w	Maximum temperature value

The default values are -10 to +60° and can be changed at MEN depending on the display type.

When changing these settings manually do not exceed the panel's maximum operating temperature range of -30 to +70°C!

Table 24. *Temperature representation*

Value	Temperature
0x22	-10°C
0x2a	0°C
0x55	+50°C

3.2.10 Display Backlight Power and Brightness Control

The microcontroller can control the display's backlight brightness and switch the display backlight power on and off (i.e., to prevent display operation outside its specified temperature ranges).

The brightness is controlled using a PWM that can be adjusted in 0.5% steps by using values from 0x00 to 0xC8 (0 to 200).

The last command, XC02C_INIT_DS, is used to control whether the display is switched on immediate after power on or whether it remains dark until the user application switches it on with a XC02C_SW_DISP command. This "silent boot" feature allows application testing and entering values in the BIOS of the onboard CPU. When the application is deployed, the initial display state can be set to off so that BIOS and OS boot messages do not appear in the field.

Table 25. *SMBus commands for display control*

Name	Command Code	Data Range	Type	Description
XC02C_SET_BR	0x17	0x00.. 0xC8	r/w	Set/get brightness level
XC02C_SW_DISP	0x20	0x00.. 0x01	r/w	Switch display on (1) or off (0)
XC02C_BR_SRC	0x19	0x00.. 0x01	r/w	Brightness source: SMB command = 0 Photo diode = 1
XC02C_INIT_DS	0x25	0x00.. 0x01	r/w	Initial display state at powerup: on = 0 off = 1

3.2.11 Optional Autonomous Brightness Control with Photo Diode

When the DC1 is equipped with a photo diode for light detection the firmware allows to pass brightness control to it. The command XC02C_BR_SRC switches control from brightness setting with the SMB command XC02C_SET_BR to autonomous setting. In this case the value is updated every 5s so short coverages of the diode don't affect brightness.

To keep the same version of the firmware for all DC1 variants, its also possible to switch to autonomous brightness control when there no photo diode is present. In that case the brightness will always stay the same.

3.2.12 Miscellaneous Commands

The firmware supports some commands that are useful to retrieve information about the build date and time.

With each call to the command *XC02C_TIMESTAMP* the firmware returns one character of the build timestamp string that is stored in the microcontroller's internal EEPROM. This helps to identify the firmware version. The values returned are concatenated in the MDIS driver and logged when the MDIS device that represents the microcontroller is opened.

The command *XC02C_ID* returns a fixed value 0xC2 that is used to identify the underlaying carrier board type. See Table 26, SMBus commands for PSU ID and firmware revision number, on page 36.

Table 26. *SMBus commands for PSU ID and firmware revision number*

Name	Command Code	Data Range	Type	Description
XC02C_ID	0xFE	0xC2	r	Fixed firmware ID
XC02C_TIMESTAMP	0x20	0x00.. 0x01	r	Build date string, one character at a time

4 Maintenance

4.1 Cleaning the Display

Please clean the display of the DC1 with a moist, soft cloth. Do not use abrasive detergents in order to avoid damaging the laminated glass that protects the display.

4.2 Fuse Protection

The DC/DC converter inside the Power Supply Unit is protected by a fuse. **This fuse is not intended to be exchanged by the customer. Your warranty for the Power Supply Unit will cease if you exchange the fuse on your own.** Please send your unit to MEN for repair if a fuse blows.

- Current rating:
  - 1A for a 72 and 110V PSU
  - 2.5A for a 48V PSU
  - 5A for a 24V PSU (standard)
- Type: fast
- Size: 4.5 x 12.1
- MEN part number: 5675-0006 (1A), 5675-0010 (2.5A), 5675-0009 (5A)

5 Appendix

5.1 Literature and Web Resources

- DC1 data sheet with up-to-date information and documentation: www.men.de/products/09DC01-.html

5.2 Finding out the Display Computer's Article Number, Revision and Serial Number

MEN user documentation may describe several different models and/or hardware revisions of the DC1. You can find information on the article number, the board revision and the serial number on two labels attached to the board.

- **Article number:** Gives the unit's family and model. This is also MEN's ordering number. To be complete it must have 9 characters.
- **Revision number:** Gives the hardware revision of the Display Computer.
- **Serial number:** Unique identification assigned during production.

If you need support, you should communicate these numbers to MEN.

Figure 6. *Label giving the board's article number, revision and serial number*